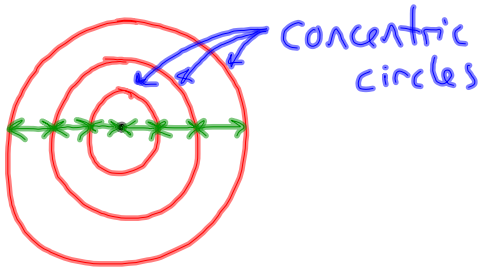
Quiz Wednesday on Sound

HW: p. 413: 2, 5, 6

p. 427: 1, 3

Doppler Effect:

- Stationary sound source:

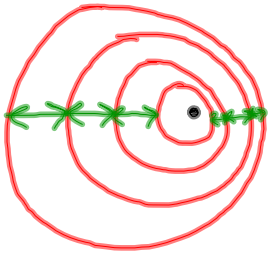


- Wavelengths equal on both sides
- lines represent places of compression
- spaces represent places of rarefaction

- Relative Motion:

either sound source moving or the surface moving

source is moving to the right



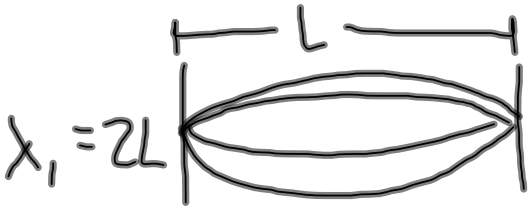
λ is shorter → higher freq. (blue shift)

λ is longer → lower freq. (red shift)

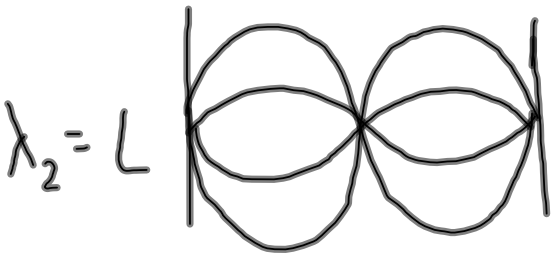
$$V = f\lambda$$

$$\lambda = \frac{v}{f} \rightarrow \text{constant}$$

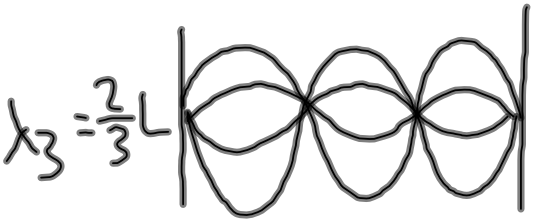
Standing Waves on a String:



fundamental frequency or first order harmonic



second order



third order

$$f_n = \frac{nV}{2L} \qquad n = 1, 2, 3, \ldots$$

f_n = frequency of the nth harmonic

n = # of the harmonic (all integers)

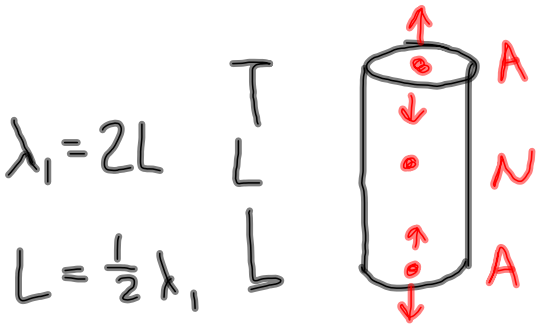
V = speed of wave on string

L = length of the string

Standing waves in an air column:

– Open/open pipe:

(open on both ends)

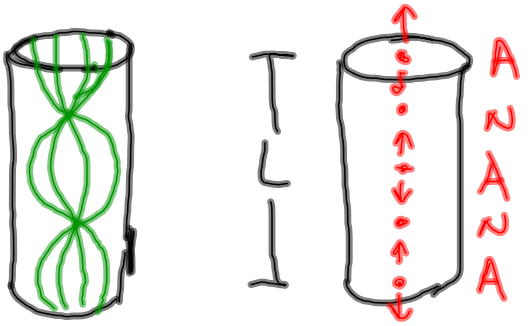


$\lambda_1 = 2L$

$L = \frac{1}{2}\lambda_1$

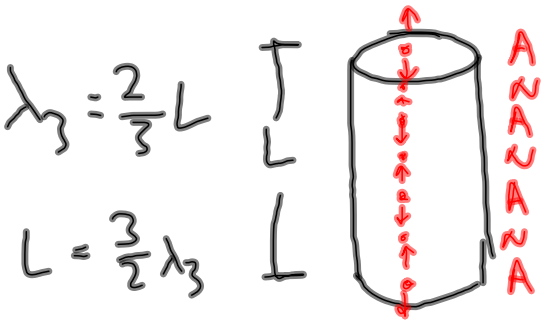
first harmonic

antinode at open ends



second harmonic

$\lambda_2 = L$



$\lambda_3 = \frac{2}{3}L$

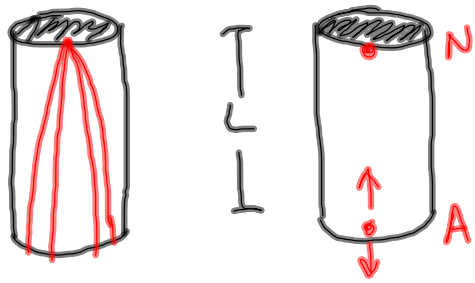
$L = \frac{3}{2}\lambda_3$

third harmonic

$$f_n = \frac{nv}{2L} \qquad n = 1, 2, 3, \ldots$$

(all integer values)

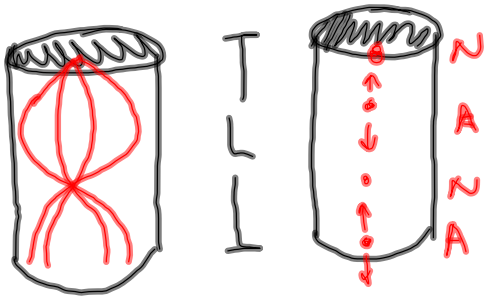
- Open/closed pipe
  (open at one end, closed on other)



first harmonic

$\lambda_1 = 4L$

Even harmonics for open/closed pipe DO NOT EXIST!

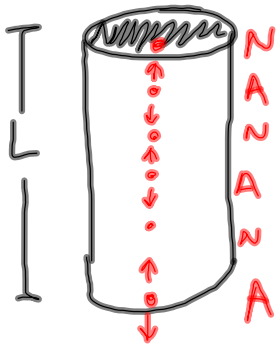


third harmonic

$\lambda_3 = \frac{4}{3}L$

$L = \frac{3}{4}\lambda_3$

$\lambda_5 = \frac{4}{5}L$



fifth harmonic

$f_n = \frac{nv}{4L}$ $\quad n = 1, 3, 5, \ldots$

What are the first three harmonics in a 2.45 m long pipe that is open at both ends? What are the first three harmonics of this pipe when one end of the pipe is closed? Assume that the speed of sound in air is 345 m/s.

open/open: $f_n = \frac{nv}{2L}$ $n = 1, 2, 3, \ldots$

$$f_1 = \frac{(1)(345\ m/s)}{2(2.45\ m)} = 70.4\ Hz$$

$$f_2 = \frac{(2)(345\ m/s)}{2(2.45\ m)} = 141\ Hz$$

$$f_3 = \frac{(3)(345\ m/s)}{2(2.45\ m)} = 211\ Hz$$

open/closed: $f_n = \frac{nv}{4L}$ $n = 1, 3, 5, \ldots$

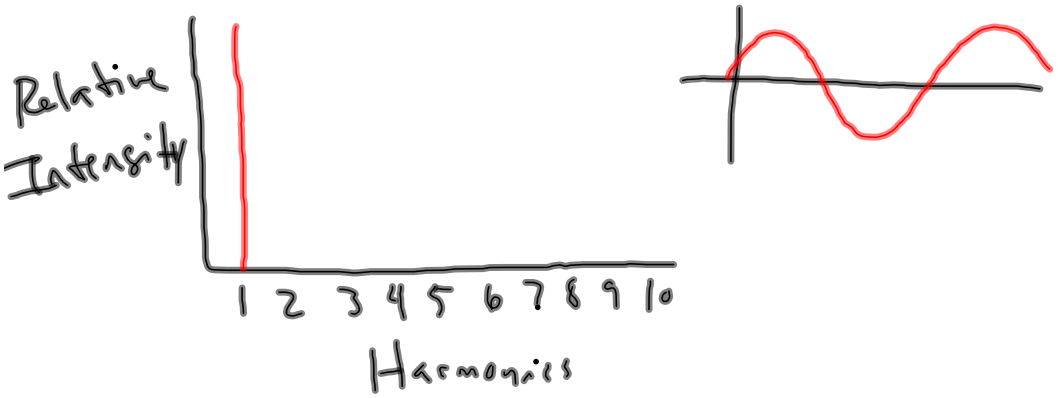
$$f_1 = \frac{(1)(345\ m/s)}{4(2.45\ m)} = 35.2\ Hz$$

$$f_3 = \frac{(3)(345\ m/s)}{4(2.45\ m)} = 106\ Hz$$

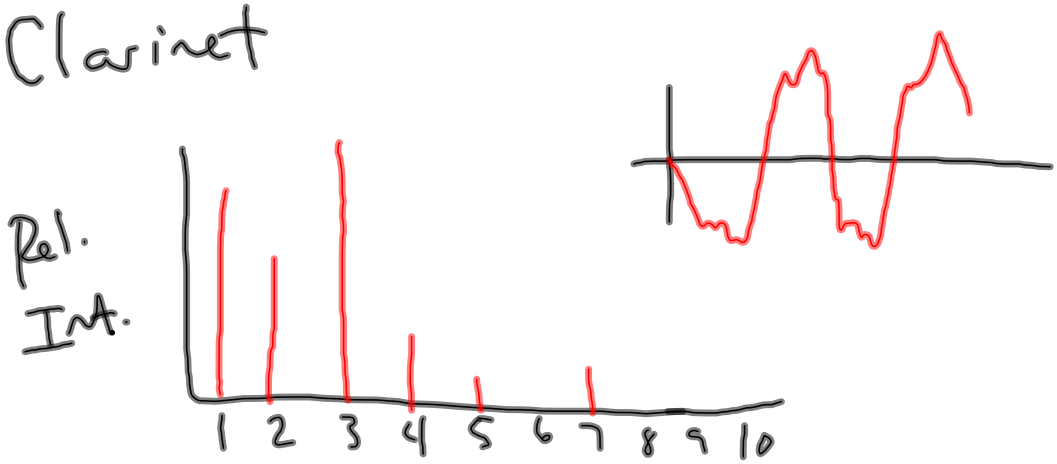
$$f_5 = \frac{(5)(345\ m/s)}{4(2.45\ m)} = 176\ Hz$$

Sound Quality → Timbre

Tuning fork



Clarinet



Viola